Dispersion modelling: From Australian Bush Fires to the Antarctic atmosphere

EGU May 8, 2020

Karen De Causmaecker, Alexander Mangold, Christophe Walgraeve, Preben Van Overmeiren, Nadine Mattielli, Stefania Gili, Andy W. Delcloo
Changing weather conditions in Australia imply larger risk for forest fires

Figure 3: Trends from 1978 to 2017 in the annual (July to June) sum of the daily Forest Fire Danger Index—an indicator of the severity of fire weather conditions. Positive trends, shown in the yellow to red colours, are indicative of an increasing length and intensity of the fire weather season. A trend of 300 FFDI points per decade is equivalent to an average trend of 30 FFDI points per year. Areas where there are sparse data coverage such as central parts of Western Australia are faded. Source: BoM 2019b.
What is the impact of forest fires on the climate?

The composition of the atmosphere is an important factor for climate change.

Forest fires emit biomass/smoke which moves through the atmosphere.

Dispersion of smoke can be observed, or modelled with a dispersion model.

Australia
January 4, 2020
Image from NASA (Aqua–MODIS)
At the Princess Elisabeth Station in Antarctica the composition of the atmosphere is measured (e.g. the Chase and Aerocloud projects)

Does smoke from the Australian bush fires reach the Princess Elisabeth Station?
Project:
Model the transport of smoke from the Australian bush fires in the atmosphere
Predict the black carbon concentration at Antarctica

Main conclusion:
Black carbon is spread over the whole southern hemisphere
At the Princess Elisabeth station $0-1\mu g/m^2$ black carbon is expected from modelling
Overview

Model setup and input data

Comparison results from the model with satellite data

Deposition in the southern hemisphere
Dispersion model
Lagrangian particle model Flexpart 9.02 in forward mode

Meteo input
3-hourly data with 0.5° resolution from ECMWF ERA-5

Input from biomass emissions
CAMS GFAS (Global Fire Assimilation System)
Emissions included:

Black carbon
December 27, 2019 - January 7, 2020
Southern hemisphere
( = 11370 releases, 500 particles/release)

Flexpart result December 27, 16:00
Use Flexpart to model the dispersion in the atmosphere

Simulation from Dec 27, 2019 to Jan 31, 2020
No aging, convection included

Flexpart results on Jan 7, 2020, integrated over entire vertical column
Overview

Model setup and input data

*CAMS GFAS, ECMWF ERA-5, Flexpart 9.02*

Comparison results from the model with satellite data

Deposition in the southern hemisphere
Flexpart results fit well with satellite data from CALIOP

Flexpart on Australian bush fires
Model setup and input data

CAMS GFAS, ECMWF ERA-5, Flexpart 9.02

Comparison results from the model with satellite data

Black carbon concentrations from Flexpart fit quite well with CALIOP satellite data

Deposition in the southern hemisphere
Black carbon reaches Princess Elisabeth and could be detected

There are no experimental results from CHASE for this period so far, but it could be detected!
Overview

Model setup and input data

*CAMG GFAS, ECMWF ERA-5, Flexpart 9.02*

Comparison results from the model with satellite data

*Black carbon concentrations from Flexpart fit quite well with CALIOP satellite data*

Deposition in the southern hemisphere

*Black carbon spreads over the whole southern hemisphere*

*At the Princess Elisabeth station 0-1 µg/m² black carbon is expected from modelling*
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Thank you!

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